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SOME PLANT ABNORMALITIES.*

GEORGE HARRISON SHULL.

THE investigation of the abnormal, either in the structure or function of organisms, is often of great value in arriving at correct interpretation of normal conditions. But any specific abnormal form is rare as compared with the frequency of the normal condition, and as no one observer is likely to discover a great number of cases, it is important that all should be recorded.

Already botanists have described very many instances of abnormal plant forms, so that the bibliography of plant teratology is already extensive. Thus Penzig² (1894) gives several thousand references to described cases of plant abnormalities.

I. FASCIATION.

This is a common phenomenon, and so widely distributed that it has been observed by all who have come into any considerable contact with plants. The present cases are described here because of certain interesting attendant characters which may throw some light upon the nature of fasciation.

A remarkable case of fasciation was observed in *Leptilon* (*Erigeron*) *Canadense* L., where a stem had a breadth, in the dried state, of 8.5^{cm}, and the overgrowth at the crest was so great as to throw it into marked undulations. The margins of this stem were apparently normal, as were also the leaves borne on them; and one margin gave rise to a series of normal axillary branches. On the broad sides of the stem, however, the leaves were reduced to a narrowly linear form 0.5–2^{mm} by 2–4^{cm}. This reduction was probably correlated with two other conditions, (1) the great crowding of the leaves, and (2) the greatly increased surface of the stem compared with its volume. It is certain

*Contributions from the Biological Laboratory of Antioch College. No. 3.

²O. PENZIG, *Pflanzen-teratologie*. 2 vols. Genoa.

that photosynthesis was carried on chiefly in the tissues of the stem itself, which had an unusually bright green color and delicate texture. No buds were produced in the axils of these reduced leaves until within 6–8^{cm} of the crest, above which point each axil produced a sessile flower bud. The whole side of the

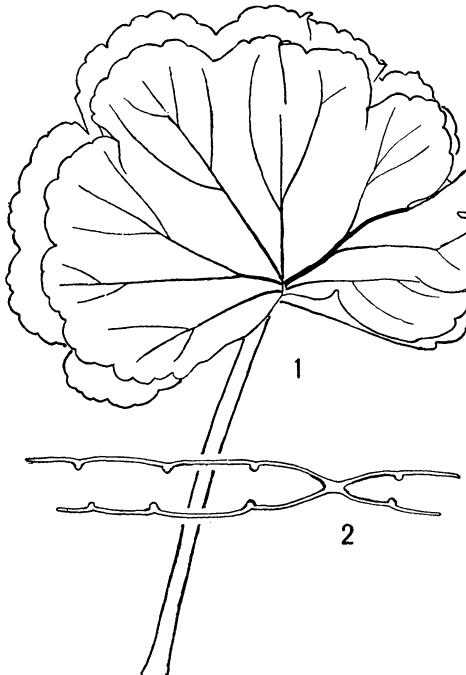
stem was covered with numerous fine ridges which, on being traced to their origin, were found to originate in the midribs of the leaves. According to Masters³ "the striae which these stems almost invariably present exhibit the lines of junction" between the stems by whose union the fasciated stem is formed; but this certainly cannot be true of the striae in this case.

In a fasciated stem of *Echium vulgare* L. there was found a greater width near the ground than at a point just below the widening at the crest. Here too the striae are simply the grooves between ridges, which are all plainly traceable to the

FIGS. 1, 2.—1, Leaf of *Pelargonium* sp. with two blades. 2, Cross section through blades of leaf shown in fig. 1, showing the reflection.

midribs of the leaves and are undoubtedly the lines beneath which lie the fibrovascular bundles originating in the leaves. By offering a different explanation of these striae the evidence of the union of stems in fasciation is lessened by so much, though not destroyed, since a union may exist without the existence of an evident line of union.

³ Vegetable Teratology 16. London, 1869.



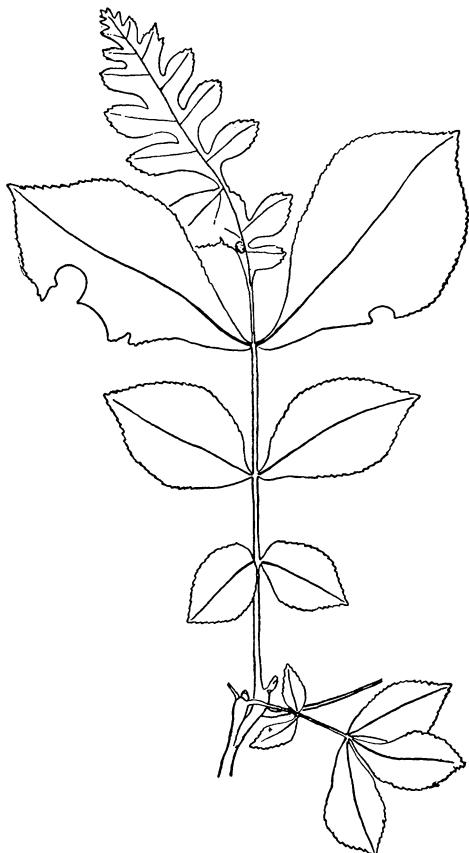
II. ABNORMAL FOLIAGE LEAVES.

One of the most common abnormalities in *Pelargonium* is the formation of peltate and funnel-shaped leaves by the growth of leaf tissue where there is normally a sinus. On a specimen which had been observed to produce a number of peltate leaves, there was also found the exceedingly interesting form shown in *figs. 1 and 2*. The petiole was about 1.5 times as broad as a normal petiole and bore two perfectly formed blades. These blades were united from base to margin along a single vein and were placed with the under sides opposed to each other. This leaf gives an excellent illustration of Bateson's⁴ (1894) law of reflection, *i. e.*, in the duplication of an organ the arrangement of the parts is the reverse of the arrangement of homologous parts in the normal organ. So perfect was the reflection in this case that the more minute details of outline were reproduced almost as perfectly as in a mirror.

In a leaf of *Hicoria* sp. (*fig. 3*), collected several years ago by the writer, the terminal leaflet was so regularly and deeply lobed as to be almost compound. This modification was decidedly "progressive," although it occurred in the terminal leaflet, where, as

FIG. 3.—Leaf of *Hicoria* sp. showing a deeply lobed terminal leaflet.

⁴ W. BATESON, Material for the study of variation, 474-575. London and New York.



has been so well pointed out by Jackson⁵ (1899) the most primitive form is to be expected. There was a small gall just at the base of the leaflet, and as it lay close to the midrib and partially deranged its tissues, the peculiar form of this leaflet may have been due to a pathological condition.

III. ABNORMAL FLORAL ORGANS.

In the summer of 1900 a small plot of *Lathyrus odoratus* L. was found to be producing a considerable number of abnormal flowers. A few of these were dissected and the parts carefully drawn at the time (figs. 4-30). The inflorescence of this species usually has only three flowers, but occasionally varies from two to four. Fig. 4 represents a double inflorescence in which a two-flowered inflorescence has apparently arisen, axillary to the lower flower of a four-flowered inflorescence. Abnormal floral organs were numerous and interesting. I have shown the parts and arrangement of the normal flower in figs. 5-7. The combination of abnormalities in each flower can best be exhibited by description of the cases examined. In each case the floral organs not mentioned were normal.

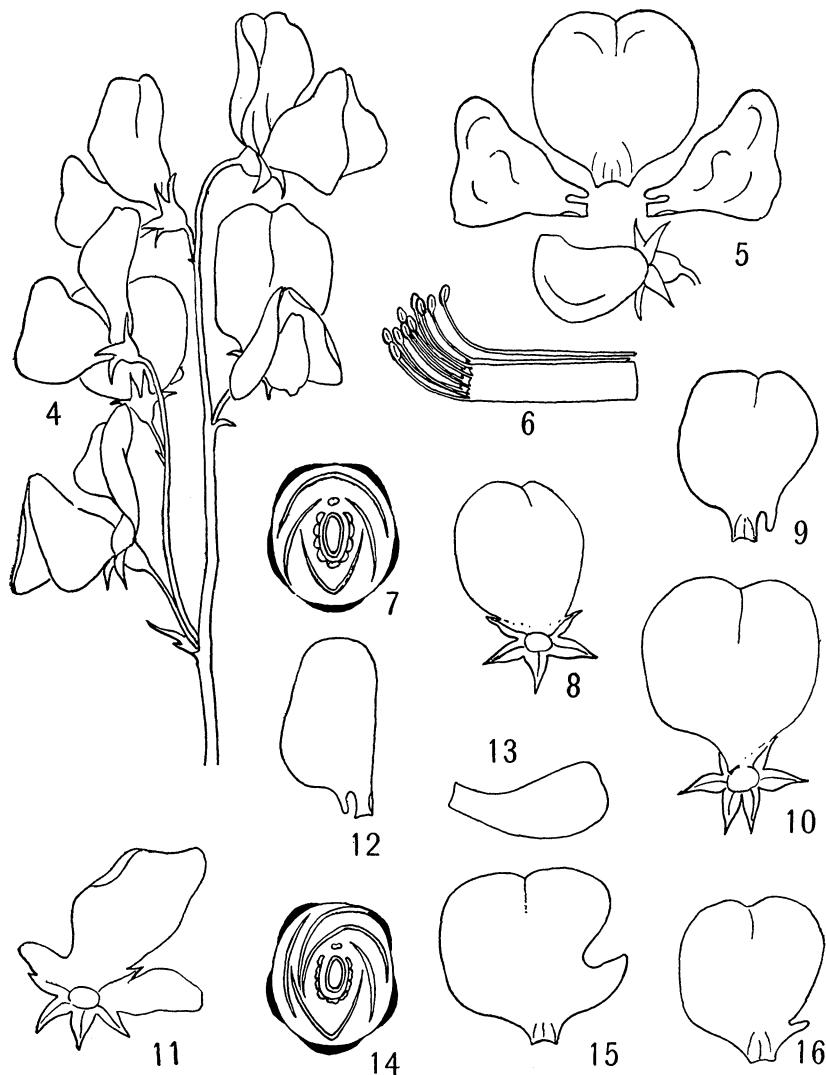
Case 1. An outgrowth from the margin of the sinus between the upper calyx teeth assumed the form and coloring of the vexillum. Vexilla two. (Fig. 8.)

Case 2. Calyx with a petaloid outgrowth from the upper sinus. This outgrowth had a lanceolate form instead of the nearly orbicular form of the vexillum. Vexilla two. Stamens eleven, all united.

Case 3. The upper edge of an upper calyx lobe dilated slightly and colored. Vexilla two, the outer having a downward hook like that of an ala, and somewhat narrower than normal. Stamens eleven, two nearly free at the base but united to the other nine above. (Fig. 9.)

Case 4. Calyx the same as in 1. Vexilla two. Stamens twelve, all united to form a tube.

⁵ R. T. JACKSON, Localized stages of development in plants and animals. Mem. Boston Soc. Nat. Hist. 5: 89-153. pls. 16-25.



Figs. 4-16.—Abnormal floral organs in *Lathyrus odoratus*. For details see text.

Case 5. Calyx normal in form but with a touch of color between the upper teeth. Vexilla two, the inner one having one margin enclosed within the carina.

Case 6. Calyx with six teeth, and with a large expansion between the upper ones. One margin of this expansion was free and inserted within the calyx like a vexillum. This structure was probably a union of a vexillum with a petaloid outgrowth of the calyx, although no line of junction was apparent. Free vexillum none. Stamens ten, united into a split tube. (*Fig. 10.*)

Case 7. Calyx as in *1*. Vexilla two, one with a downward hook. Stamens eleven, united into a tube.

Case 8. Calyx as in *1*. Rest of flower normal.

Case 9. The tissue of two of the upper sinuses of the calyx was expanded into irregular petaloid bodies, the upper one with a divergent lateral lobe. Vexilla two, each having the form of half a normal vexillum, one with a prominent downward hook. Alae abnormally narrow, curved upward and outward, and lacking the usual overlapping edge. Stamens twelve, of which eleven were completely united, the twelfth partially adherent. (*Figs. 11-13.*)

Case 10. Calyx with a slight petaloid expansion which was united edge to edge with the outer vexillum. Vexilla two, each having one margin enclosed in the carina. One ala external. (*Fig. 14.*)

Case 11. Calyx the same as in *1*. Vexilla two. One ala narrow and much curved upward. Stamens nine united, one free, and one nearly free.

Case 12. Calyx with six teeth. Vexilla two, each with a lateral lobe, one lobe unusually large. (*Fig. 15.*)

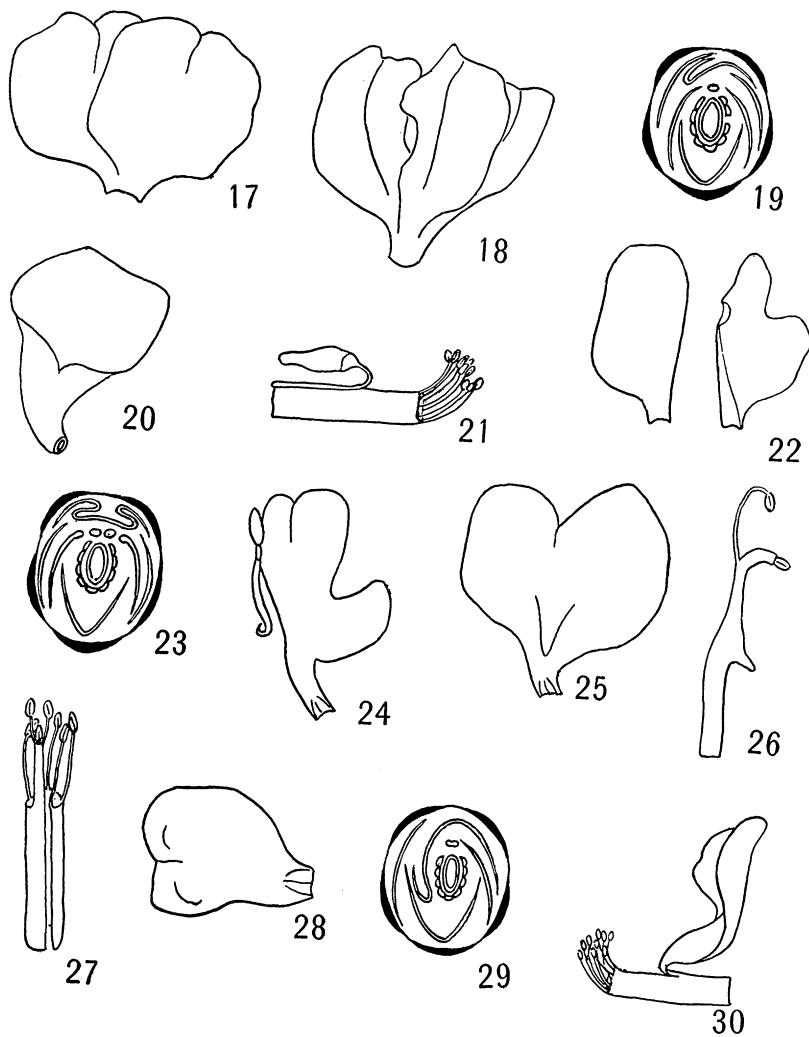
Case 13. Calyx teeth six, the lower two narrower and more approximate than the others. Vexilla two. Stamens nine united, three free.

Case 14. Vexilla two. Stamens nine united, and two free.

Case 15. Vexilla two, each with a lateral basal lobe on the upper side. (*Fig. 16.*)

Cases 16 and 17. Vexilla two, the second having one margin enclosed in the carina. Stamens ten united, one free.

Case 18. Vexilla two, which were slightly united edge to edge at the base. Stamens diadelphous, two and nine. (*Fig. 17.*)



Figs. 17-30.—Abnormal floral organs in *Lathyrus odoratus*. For details see text.

Case 19. Vexilla three, all alike and nearly normal in form.

Case 20. Vexilla three, all united. Stamens nine united, three free. (Fig. 18.)

Case 21. Vexilla three, the middle one with one side folded

back upon itself. Stamens triadelphous, one, two, and seven. (*Fig. 19.*)

Case 22. Vexillum with margins turned backward and coalesced, forming a funnel which was adherent to the calyx tube at the base. Stamens two free, nine normally united, with a twelfth united for two-thirds of its length. This filament was slightly enlarged and colored, and had its anther converted into a body of the same color and texture as the petals. (*Figs. 20, 21.*)

Case 23. Vexilla two, the second shaped like half the first and balanced on the other side by a petaloid stamen having a yellow spot, corresponding to an anther, on the inner margin. Other stamens normal, nine united and one free, the free stamen arising between the two petaloid bodies within the normal vexillum. (*Fig. 22.*)

Case 24. Vexillum doubled upon itself on both sides. Alae two on each side, the supernumerary alae having the hooks on the lower side, *i. e.*, toward the normal alae, in this respect appearing as a reflection of them. One of these supernumerary alae occupied the position of a free stamen. Stamens nine united, two free. (*Fig. 23.*)

Case 25. Vexilla two, the first notched to one side of the center, the second with a large lateral lobe, and having one margin enclosed in the carina. The enclosed margin of the second vexillum bore a small appendage which was nearly spiral below and ended above in an erect wing. This appendage was probably the homologue of an anther. (*Fig. 24.*)

Case 26. Vexilla two, the outer joined below, margin to margin, with one ala.

Case 27. One ala joined to the first vexillum, this double petal external. Second vexillum of normal form, but with one margin included in the carina. Upper stamen free (as normal), beside it a broad filament with a lateral overlapping hook and colored like a petal. This broad filament was topped with an anther and had a normal filament branching from it at a point two-thirds of its length from the base. The remaining stamens were united into a split tube bearing upon its outer margin four

normal filaments, and one broader filament formed by the union of three filaments. This bore at its summit one sessile anther, and at each side of this sessile anther a short-stalked one. (*Figs. 25-27.*)

Case 28. One ala external and lacking the usual hook. One side of the vexillum folded back and included in the carina. (*Figs. 28, 29.*)

Case 29. Nine stamens united, the tenth united to the other nine for half the length of the tube, then spreading back with the form and coloring of a second vexillum. (*Fig. 30.*)

These abnormalities may be summarized as follows:

1. Abnormalities of the calyx. (*a*) In two cases there were found six calyx teeth, and (*b*) in eleven cases a petaloid inflation grew from the sinus between the upper teeth. This petaloid outgrowth varied from a small colored area in a normally formed sinus to an expanse of tissue having the size, form, and color of a perfect vexillum.

2. Abnormalities of the vexillum. (*a*) In twenty instances there were two vexilla, and in three cases three vexilla were found. In about half, the second vexillum was normal in form, the variations from this being in two directions, (i) toward the wing with its downward hook on the one hand, and (ii) toward the stamen on the other. (*b*) In two cases there was a union between an ala and the outer vexillum. (*c*) Union of the vexilla was found in two instances.

3. Abnormalities of the alae. (*a*) In two flowers the alae were unusually narrow and curved upward. (*b*) In two cases, as mentioned above, there was a union between an ala and a vexillum. (*c*) In one case there were two alae on each side.

4. Abnormalities of the stamens. (*a*) An approach to the form and coloring of the petals. Almost every degree of petalody was found from a petaloid appendage or a broadened filament with a hook, to the form of half a vexillum. (*b*) Three flowers had two free stamens, and two had three free stamens. (*c*) Thirteen had an unusual number of united stamens, mostly ten or eleven, in two instances reaching twelve. (*d*) In several

the stamens were triadelphous, one, two, and nine, or one, two, and seven.

5. Abnormal aestivation. (a) In three cases one ala was external to the vexillum. (b) In six instances the supernumerary vexillum had one margin enclosed within the carina. (c) In several cases there was an abnormal folding of the vexillum upon itself.

There have been but few cases recorded of the union of sepals in *Clematis*, and belonging as it does to a family which typically has all the parts distinct, the union of parts is all the more remarkable. Perhaps the most noteworthy case of this kind is that described by Jaeger⁶ (1828), in which the sepals of *Clematis Viticella* L. were united into a bilabiate tubular perianth. Ch. Fermond⁷ (1884) has found many cases of three-parted perianths in *Clematis* sp., and Cockerell⁸ (1897) remarks upon the common occurrence of the union of two sepals in *C. ligusticifolia*. In a specimen of *Clematis* growing at Edgewood, North Hampton, O., said to be a seedling of *C. Jackmani* of the gardeners, there are found every year many cases of similar union of sepals, and in varying degrees of union, from the slight union of two sepals to the complete union of all the sepals into a regular, tubular, gamosepalous flower (*figs. 31-34*). This complete union, shown in *fig. 34*, does not occur often, but I have found two like the one figured. If this is a seedling of *C. Jackmani*, its variations are rather remarkable because of the almost absolute invariability of that form. In the "Star of India"⁹ *Clematis* there is a marked tendency to depart from the typical four-parted perianth, and to produce flowers having six sepals. In this species are found many cases of division or of union of sepals.

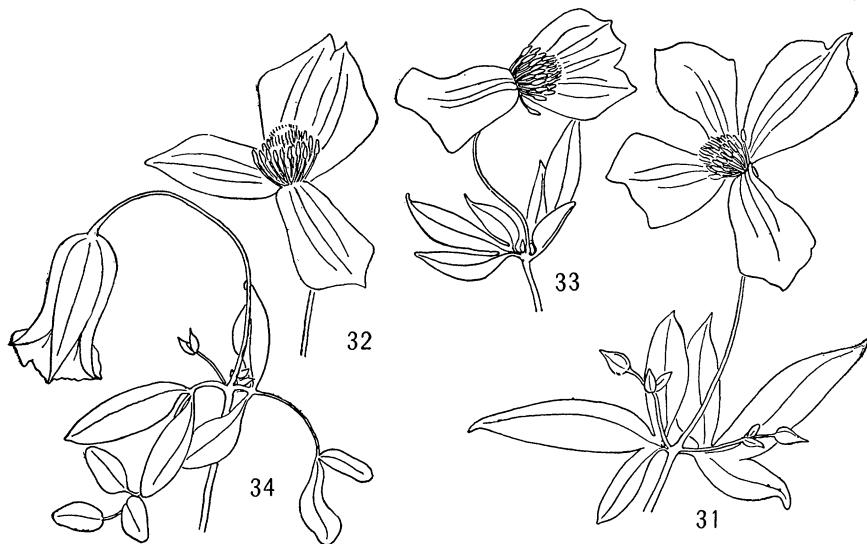
⁶Nov. Act. Acad. Caes. Leop. 1828: 641. *pl. 37.*

⁷Essai de phytomorphie, ou étude des causes qui déterminent les principales formes végétales. 2 vols. Paris.

⁸BOT. GAZ. 24: 293.

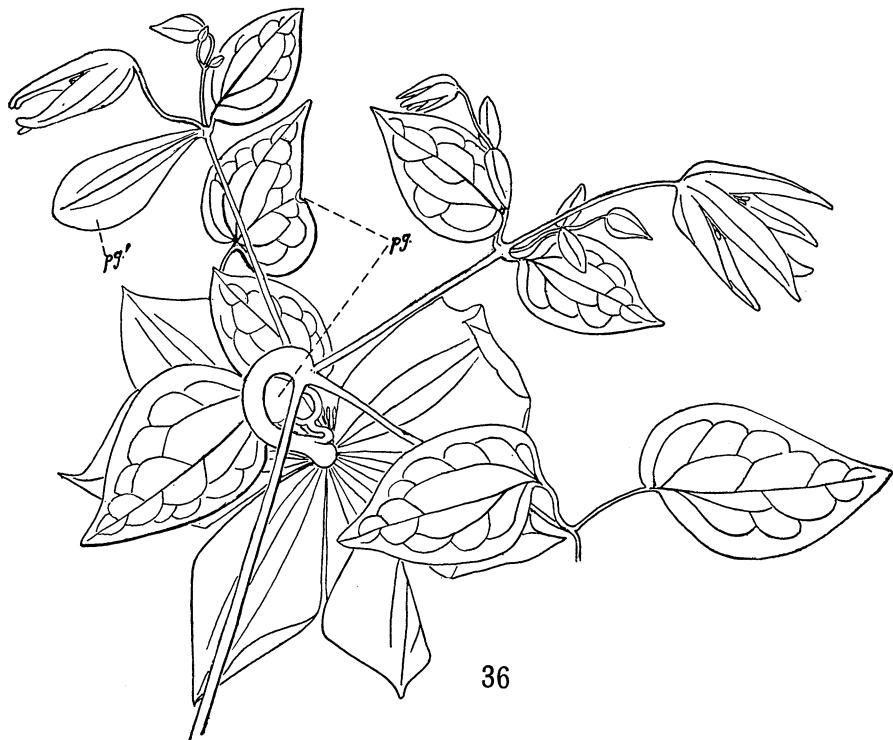
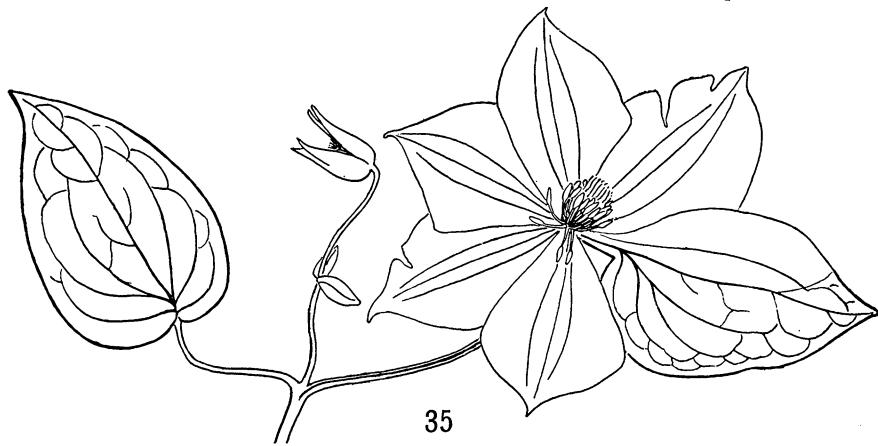
⁹This is the garden name. I have been unable to determine its specific relationship.

Two of the most striking cases of abnormality in *Clematis* are shown in *figs. 35* and *36*, although similar cases have been frequently described, indicating that the displacement and coloring of the leaves which are nearest the flowers is a common abnormality in the genus. The two figured were both collected from the same plant of the "Star of India" *Clematis*, although several seasons intervened between them. In *fig. 35* there



Figs. 31-34.—Abnormal floral organs in a seedling of *Clematis Jackmani* (of gardeners); 31, normal flower; 32, two sepals united; 33, three sepals united; 34, all the sepals united into a gamosepalous perianth.

appears what at first seemed to be a reversion of the greater part of a sepal to an ordinary foliage leaf; the remainder retained the form, delicate texture, and rich coloring characteristic of the sepals. On the examination of the normal inflorescence, however, it appears that this organ, instead of being a partly reverted sepal, in reality is the result of a coalescence of a sepal and a leaf from the node next below the flower. The chief evidences of this are found in the absence of one of the leaves from that node, and the presence of a marked decurrent line extending from the leafy organ down the side of the peduncle to the node.



Figs. 35, 36.—Abnormal floral organs in "Star of India" Clematis (of gardeners); 35, union of leaf and sepal; 36, union of peduncle and petiole, one leaf with leaflets partly colored (pg), and one leaf entirely changed to a sepaloid body (pg').

The bud which is normally axillary to the removed leaf failed to develop.

Fig. 36 is a somewhat similar case, but more complicated. Here, too, there is an adnation of the petiole of the leaf to the peduncle, and two of the three leaflets are partly colored like sepals. From the groove at the side of the coalesced petiole and peduncle arises an axillary branch. This branch bears, at the next node above, a leaf which in every respect resembles a sepal, and which failed to produce a bud in its axil.

All the cases here described and figured are in the herbarium of the writer, except those of *Lathyrus* which were dissected, and the parts sketched and described from the fresh material.

YELLOW SPRINGS, O.